Synopsis for the Degree of Ph.D.

On

The Nexus between Crop Diversification and Agricultural Development in Bihar: A Regional Level Study

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Submitted
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A. Title of the Proposed Work: "The Nexus between Crop Diversification and Agricultural Development in Bihar: A Regional Level Study"

B. Problem to be studied

B.1. Introduction

In the agrarian economy, crop diversification promotes agricultural expansion. (Von Braun, 1995; Pingali and Rosegrant, 1995; Ryan and Spencer, 2001). Crop diversification not only minimises the risk of total crop failure but also gives some alternative sources of income for farming community. Farmers that use a single-crop farming method have a greater risk of crop failure, price shocks, and other hazards. Therefore, in order to alleviate adversity and support sustainable livelihoods in rural areas, crop diversification has become a crucial tool for the farming community in the agrarian economy.

In post-reform period, Indian agriculture has undergone a radical shift from mono-cropping to multi cropping system. Due to the fast growth of the economy, there has also been a shift in consumer habits away from traditional cereals and toward a more complete and nutritious diet of fruits and vegetables, etc. Consequently, India's agricultural diversification now includes high-value crops. (Kumar & Gupta, 2015). The agricultural crop basket varies greatly throughout the states because of unique regional peculiarities like climate, infrastructure, and resource endowments. One of India's most backward regions is the eastern area, which comprises the states of Bihar, Jharkhand, Odisha, and West Bengal. These states are considered as high population growth, small landholdings, and inadequate rural infrastructure. Even though Bihar produces a wider variety of crops than other eastern Indian states, it still exhibits some regional features in terms of agricultural development (Kumar et al. 2012). Bihar is predominantly an agrarian state, with farming serving a subsistence level. Regarding agriculture, it is among the strongest states in the country. The employment rate in the state's agriculture industry is about 80%, higher than the 58% national average. Bihar is the fourth greatest producer of vegetables and the eighth largest producer of fruits in India. The primary source of wealth in Bihar is agriculture. The crop basket of the state is greatly diverse and need serious investigation for resurrection and consolidation of agriculture in Bihar. Therefore, the present researcher is focused to investigate the nexus between crop diversification and agricultural development in Bihar.

B.2. Statement of Research Problem

The agrarian economy of Bihar is undergoing a phase of transformation, and as a result, there have been changes in the composition of the agrarian structure with regard to income sharing, land holding size, and land use pattern. These changes have occurred along with crop diversification from the cultivation of cereals to high-value products, the progress of new marketing opportunities, the expansion of urbanization and linkages with the non-farm sector (Pohit et al. 2019). In the state economy, almost one-fourth of the GSDP is covered agriculture, whereas more than 70% of the workforce in rural Bihar still depends on the agricultural sector (GOB). The performance of agriculture in terms of level of agricultural development and nature of crop diversification has followed an uneven path of development over a period of time and shows huge variations at the regional level in Bihar. The pace of agricultural diversification has accelerated in the past few years as a result of growing rural market facilities, rapid urbanization, irrigation system expansion, and infrastructure development. The change in land

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use pattern and availability of resources, along with changes in the consumer food basket, are also responsible for crop diversification (Singh, 2011).

Crop diversification and level of agricultural development usually varies across the region due to different regional characteristics in terms of infrastructure development, utilization of agricultural resources, etc. Therefore, in order to make some specific strategies to improve the farmers' conditions, it is crucial to assess the levels of crop diversity and their relationship to the level of agricultural development at the district and regional levels. In this backdrop, the main objective of this proposed work is to analyse a nexus between crop diversification and agricultural development at the regional level in Bihar and also identifying the main determinants of crop diversification at regional level.

There are a number of issues relating to the crop diversification and level of agricultural development that draw attention as these have not been sufficiently addressed. Some relevant issues are as follows:

1. How the nature of the crop diversification affects the land use pattern and vice versa?

2. To what extent it is correct to say that the mobilization and utilization of agricultural resources are influenced by the level of crop diversification?

3. How the nature of crop diversification and agricultural development varies at the regional and district level in Bihar?

4. How the production and productivity are affected by the crop diversification at the regional level in Bihar.

It is precisely these problems that have attracted the present researcher and the proposed work seeks to address some of these.

C. Brief Review of Literature

Brief review of the literature and conceptual framework of the proposed work

a. Crop Diversification: Conceptual framework

A key element in determining the effectiveness of agriculture is the degree and nature of crop diversification. Numerous academics have investigated the various forms and levels of crop diversification at the regional level. In his discussion of the type and extent of crop diversification in West Bengal, Bhattacharyya (2008) noted that the state's crop diversification was very low when compared to the national average. A study by Ghosh (2013) found that agricultural diversification is progressively rising over time.

Kamau (2011) defines farm crop diversity as: (1) cultivating different crop species; and (2) producing different ecotypes and multiple varieties of the same crop in an effort to

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maximize the yield of primary products. Buguk et al. (2003) also explained that farming communities cultivate crop species that are genetically diverse to manage production risk and ensure survival. According to Dequech (2007), diversification involves the expansion of farm crop composition, activities, and outputs within a defined space and time. As showed by Khawar (1997), crop diversification is an addition of new or additional crop species/varieties at the farm level. The general perception of crop diversification is a move away from traditionally farmed, less productive crops and toward newer, more profitable crops. Farmers have the opportunity to grow a variety of crops on their land through crop diversification. (Pope and Precott, 1980). According to Dorsey (1999), Crop diversification offers the chance to choose and identify a crop or crop species for commercial production.

Crop diversity has two main properties, according to Samuelson (1967). A high degree of crop diversification minimises farming risk, and it also expands a farmer's production possibilities. Crop diversification, according to Ashfaq et al. (2008), reduces the chance of crop failure while offering a variety of opportunities to grow different combinations of crops in a particular location. Enhancing land utilization and increasing crop net returns are two further benefits of crop diversity.

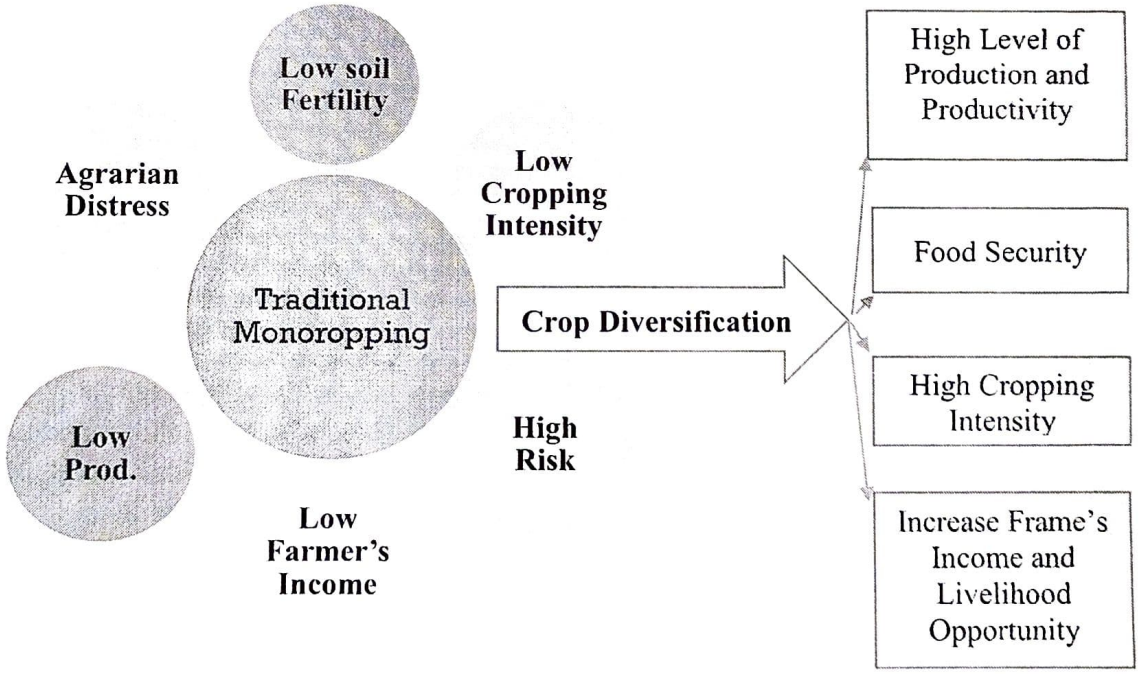

Fig.1 Traditional Monocropping Vs. Crop Diversification

Crop diversification is one of the choices followed to spread risks over multiple activities and make an economically best choice (Bowman and Zilberman, 2013; Arslan et al., 2018). The study of Di Falco and Chavas (2009) has also examined that crop diversification is one of the strategies that allow farming community to enhance the ecosystems, provide a range of viable crop varieties for the market, and reduce risks associated with price volatility and climate variability Moreover, it has been noted that

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crop diversification increases agricultural output, preserves the ecological diversity of crop species in their natural habitat, and helps farmers reduce the harmful effects of extreme weather and environmental factors. According to Barbieri and Mahoney (2009), the main objective of crop diversification is to minimize the risk of crop failure, maximize the benefit from market opportunities or market expansion and improve household revenue.

b. Determinants of crop diversification

Over time, crop diversification has been significantly influenced by the degree of agricultural development at the regional level. The relative level of crop diversity in the region is mostly determined by agro-climatic conditions, resource endowments, and infrastructure development. (Satyasai and Vishwanath 1996, Ryan and Spencer 2001). The length of rural roads, the availability of agricultural resources and rural financing, and the reduced cost of imports under a liberalized regime have become the main barriers to crop diversification. A study on the nature and degree of crop diversification done by Saraswati et al. (2011) reveals that the growth of infrastructure, which includes things like fertilizer availability, market accessibility, irrigation water supply, transportation, and technology, affects agricultural diversity.

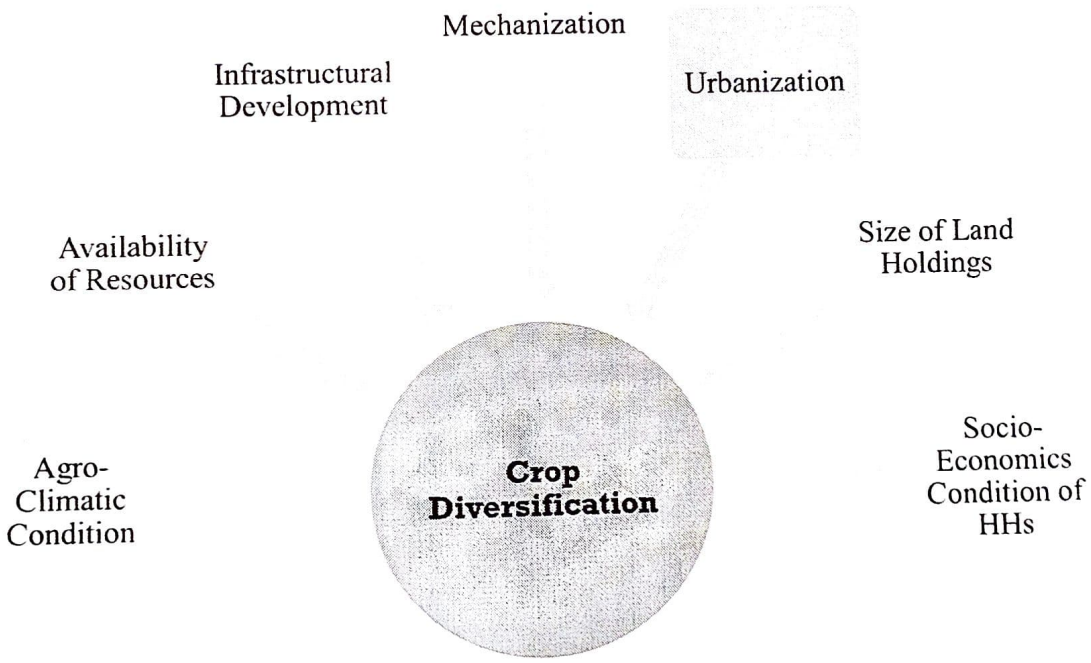

Fig.2 Determinants of crop diversification

Technological innovation has a good impact on crop diversification, according to Bhattacharyya (2008). It was also shown that agricultural diversification was positively impacted by crop pricing and infrastructure development. Additionally, he recommends that institutional assistance swiftly increases the degree of diversification. Pingali &

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Khawaja (2004), argue that Crop diversity and urbanization level have a good correlation. Demand-side variables are also seen to be a major driver of agricultural diversification in India. An increase in urbanization and economic expansion is driving up demand for high-value goods. (Pokharel 2003; Wickramasinghe 2003; Joshi et al 2004, Barghouti et al 2003).

The analysis of eminent scholars has revealed a significant correlation between the degree of urbanization, as well as the advancement of the infrastructure and economy, and the diversification of extremely valued crops. A wide road network, transportation, and a well-equipped system for storage and handling are all made possible by urbanization, which also generates market demand for a valuable crop (Rao et al. 2006). According to Mesfin et al. (2011), Crop diversification is strongly impacted by the availability to market information. It is more probable for farmers with access to market data to diversify their crops since they are aware of crop supply, demand, and prices.

Another study on crop diversification done by Ashfaq et al (2008) explained that the size of the farmer's land holding and non-farm income have an impact on crop diversity. Similarly, the study of Moti (2012) also found that the dispersion of land holdings appears to be the most important factor in crop diversity. The degree of diversification will rise in proportion to the size of the land. The study by Ibrahim et al. (2009) found that crop diversification level is influenced by a number of socioeconomic parameters, e.g, HH size, education level, etc.

c. Econometric tools

Crop diversification was measured in the study by Ghosh (2013) using the Herfindal index, which also looked at recent changes in cropping patterns and the degree of crop diversification. In the study of Ashfaq et al (2008) entropy index has been used to measure crop diversification and, a multiple regression model has been used to identify the affecting factors of crop diversification. Bhattacharya (2008), on the other hand, measured crop diversification using the Simpson diversification index. This index would be used as a dependent variable in a regression equation so as to determine the separate effect of each individual exploratory variable on crop diversification. Ibrahim et al. (2009) conducted a study on agricultural diversification that utilized an ordinary least squares regression model to find the primary factors of crop diversity. The study was also based on the Simpson Index of Diversification.

In view of this, the aim of this study is to examine the kind and degree of agricultural diversification in Bihar, which is a mostly untouchable state in this regard. The Simpson diversity Index would be used to explain the state's crop diversity. Despite the fact that Bihar has been regarded as India's most backward state in terms of agricultural development, a number of variables would be chosen for the purpose of analysis in order to examine the reality of diversification and its determinants. The HDI method would be used to measure agricultural development at the district and regional levels.

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D. Research Gaps

Some topics have not been thoroughly investigated, even though scholars have made significant efforts to address the matter. The present researcher, based on a succinct review of the literature, could identify the following gaps in literature.

1. The relationship between crop diversification and land use pattern has not been sufficiently explored at regional level in Bihar.

2. Most of studies related to crop diversification provide explanatory research about the level of crop diversification. There is hardly any effort to explain how the nature of crop diversification differ at regional level and factors responsible for it.

3. There is less attempt has been made to trace the factors that influence the impact of crop diversification on the level of agricultural development in Bihar.

Due to these gaps in the available literature, the current researcher has been motivated to investigate and analyse the nature and extent of crop diversification as well as how it relates to the regional agricultural development.

E. Objective of the Study

1. To examine the nature of crop diversification at the regional level in Bihar and analyse how it differs from one region to another.

2. To analyse the nexus between crop diversification and the level of agricultural development at the regional level in Bihar.

3. To identify the main determining factors of crop diversification at the regional level in Bihar.

F. Hypotheses of the Study

1. There exists a significant differences in the level of crop diversification at the regional level in Bihar.

2. The crop diversification significantly affects the agricultural development at the regional level in Bihar.

3. The nature of crop diversification is primarily affected by land use pattern and agro-climatic condition of the region.

G. Database and Methodology

The proposed work would be based on secondary data and secondary would be collected from various sources e.g., Directorate of Economics and Statistics (Department of planning and Development, Government of Bihar), Agricultural Statistics at a Glance, Agricultural Census Division, Ministry of Agriculture, New Delhi.

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Econometric Tools

Some appropriate econometric tools would be used to analyse the nature and magnitude of crop diversification.

a. Simpson Index of Diversification

There are several methods to calculate the degree of crop diversification. In order to understand the ground reality of regional dimensions and variations in crop diversification, a Simpson Index of Diversification would be used. The Simpson Index provides a clear dispersion of crops on cultivable land and is easy to explain and interpret. The Simpson index of crop diversification (SID) is given by

$$SID = 1 - \sum_{i=1}^{n} Wi^2$$

$$\text{Where, } W\boldsymbol{i} = \frac{Xi}{\sum Xi}$$

X_i is the area of the i^{th} crop, and W_i is the proportionate area of the i^{th} crop in the total cropped area.

Simpson index values vary from 0 to 1, the highest value of SID (1) indicates a high level of diversification in the study area and the lowest value of SID (0), indicates no diversification.

b. Level of Agricultural Development

For computing the level of agricultural development in the study area, a development indices would be measured on the basis of some suitable (Table-1) variables. For the computation of agricultural development index, normalization procedures would be conducted.

Table-1
List of Variable (Level of Agricultural Development)

S.N.	Indicators		
1	Land Use Pattern	1.1	Cropping Intensity
		1.2	% of Net Sown Area to Total Cultivable Land
		1.3	% of fallow land to total Cultivable land
2	Performance of Agricultural Activity	2.1	Food grain Productivity
		2.2	Non-Food grain Productivity
		2.3	Per Head Food Grain Production
3	Work Force Performance	3.1	% of Cultivators to Total Main Workers
		3.2	% of Agricultural labours to Total Main Workers

Source: Computed by Researcher

Goalposts of the indicators would be selected in the process of normalization. Minimum and maximum values (goalposts) are set in order to transform the indicators expressed in different units into indices between 0 and 1. These goalposts act as "the natural zeros" and "aspirational targets", respectively, from which component indicators are standardized (UNDP). The normalized value would be calculated as follows:

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$$Normalized\ Value = \{\ \frac{(\text{Actual value - Minimum value})}{(\text{Maximum value - Minimum value})}\}\ldots(1)$$

If Indicator is negatively associated, then equation has been changed to

$$Normalized\ Value = \{\ 1 - \frac{(\text{Actual value - Minimum value})}{(\text{Maximum value - Minimum value})}\}\ldots.(2)$$

Finally, arithmetic mean has been used for the calculating status index of agriculture.

c. ANOVA

To analyse which classifying variables, the difference between the clusters is significant, a one-way ANOVA would be used. The ANOVA offers F values and significance levels to demonstrate whether any of these mean differences are significant.

F= MST/MSE.....(1)

$$MST = \{(\sum_{i=1}^{k}(Ti^2/\ ni) - G^2/n\ )\ /\ (K-1)\}$$

$$MST = [\ \sum_{i=1}^{k}\sum_{j=1}^{ni} Y^2ij\ - \sum_{i=1}^{k} T^2i/\ ni]\ /\ [n-K]$$

F = Variation Ratio for the overall ratio
MST = Mean squire between group
MSE = Mean squire within group
Y_{ij} = Observation
T_i = Group total
G = Grand Total of all observation
n_i = number in group i
N = Total Number of observation

d. Regression Analysis

Regression analysis techniques has been used to identify and quantify the factors influencing and determining crop diversification

$$\mathbf{Y= A + B_1\ X_i + B_2\ X_2 + B_3\ X_3 + \ldots\ldots\ldots\ldots + B_n\ X_n + u_t}$$

Y = Dependent Variable
$X_1, X_2, X_3, \ldots X_n$ = independent Variable
A = intercept
$B_1, B_2, B_3, \ldots B_n$ = Parameters

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e. **Cluster Analysis**

In order to examine how different districts of the state are situated and the degree to which they are close to each district in terms of diversification and agricultural development, a cluster analysis would be used. A Hierarchical cluster (Ward's Method) would be used. For this purpose, the agglomeration schedule would be computed and proximity matrix and dendrogram techniques would be used to provide the optimum number of clusters.

H. The Study Area

Bihar is located in the plains of the Ganga basin and endowed with alluvial soil with abundant water resources, especially groundwater resources. The main source of occupation in the countryside is still agricultural sector. Droughts and floods have devastating effects on farmers, livestock and crop diversification. In the northern part of Bihar, the volatile nature of climate conditions is one of the major challenges of agricultural activities. From one perspective, northern Bihar is normally an exceptionally flood-inclined region and other hand, southern Bihar is profoundly dry season inclined (Government of Bihar, 2012). Considering agro-climatic circumstances, Bihar can be divided into four regions for analysis purposes (Table-2).

Table-2
Agro- Climatic Region of Bihar

SN	Region	District
1.	Northern West	West Champaran, East Champaran, Siwan, Saran, Sitamarhi, Sheohar, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur, Gopalganj, Begusarai
2.	Northern East	Purnea, Katihar, Saharsa, Supaul, Madhepura, Khagaria, Araria, Kishanganj.
3.	Southern East	Sheikhpura, Munger, Jamui, Lakhisarai, Bhagalpur & Banka.
4.	Southern West	Rohtas, Bhojpur, Buxar, Bhabhua, Arwal, Patna, Nalanda, Nawada, Jehanabad, Aurangabad, Gaya

Source: Economics &Statistics Division, Planning Department, GOB

The Northern West region which covers 13 districts of Bihar, is highly fertile for agriculture. Despite having extremely fertile land and favourable climatic condition, it is the most backward region of Bihar in terms of socio-economic indicators. Whereas the Northern East region of Bihar (which covers 8 districts) is mainly known as the producer of horticulture and commercial crops. Six districts make up the state of Bihar's Southern East area. It is often hilly, has a large proportion of uncultivated land, and produces less food grains than other regions of the state. (Khan & Sadaf, 2022). The state's Southern West region enjoys certain advantages in the agricultural sector because of its high level of socio-economic development and growing urbanization.

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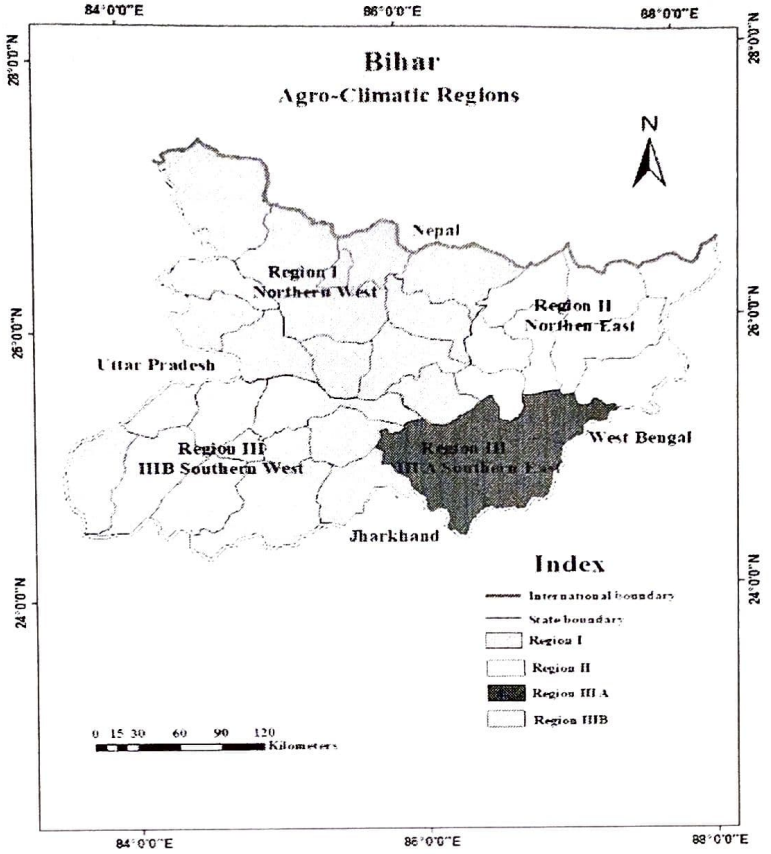

Fig.3 Agro-Climatic Regions of Bihar

In Bihar, rice, wheat, and maize are considered as the three main cereal crops. In every part of Bihar, rice is grown as the primary monsoon crop. The production of wheat increased at a faster rate during the period of green revolution and covered the status of the main crop of the *rabi* season. In Bihar's southern region, pulses such mung beans, lentils, and peas are predominantly grown as crops. (Ahmad el al 2017).

I. Justification of the Study

The proposed work assumes critical importance because of a number of reasons e.g.

- First, it is indisputable that agriculture plays a crucial role in the economic development of India, even with its steady fall in GDP contribution. Ultimately, the status of agriculture and the fortune of farming community still depend on the level of crop diversification.

- Second, the nature and degree of crop diversification that now exists may help to explain a number of issues facing the agriculture sector, such as the unviability of agriculture, stagnation of productivity and production, increasing regional imbalance, etc.

- Third, although, livelihood opportunity of the farming community is a part of the agrarian structure of the economy but the structure of the agrarian economy is also influenced by nature of the crop diversification.

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J. Chapter Plan of the Proposed Work

The thesis is tentatively planned in the following chapters-

Chapter–I Introduction: The first chapter of the proposed work would introduce the topic in some detail and draw the outlines of the study. It will very briefly explain the present scenario of crop diversification in Bihar. The chapter would explain the plan of the work.

Chapter–II Review of Literature: The second chapter would review the literature related to the nature of crop diversification and agricultural development in Bihar. The current literature would be categories on the basis of the conceptual framework, methodology of the study and findings.

Chapter–III Data Source & Methodology: The third chapter would explain the research design and detailed methodology of the proposed work. The chapter would mention the computational and analytical tools used in the study.

Chapter- IV An Empirical Analysis of the Crop Diversification in Bihar: A Regional Level Study: The fourth chapter will explain the theoretical aspects of crop diversification. SID would be used for measuring crop diversification at the regional level. It will also try to explain how crop diversification differs at the regional level.

Chapter- V: Determinants of the Crop Diversification at Regional Level in Bihar: The chapter would identify the main determinants of crop diversification in the study area. Regression analysis would be used in this regard.

Chapter–VI: The Crop Diversification and Level of Agricultural Development in Bihar: A Regional Level Study: The chapter would investigate the relationship between the level of crop diversification and agricultural development in the study area. The attempt would be made to see the degree and direction of the relationship.

Chapter-VII Conclusion and Recommendations: The last chapter of the thesis will provide a brief summary of the work done and suitable suggestions to help promote a pro-farmer crop diversification that is desirable.

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